D28

On the critical thickness of synchrotron x-ray filters and filter design

Z. B. Wang and T. M. Kuzay
Experimental Facilities Division, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois

A “critical thickness” for a synchrotron radiation x-ray filter exists. Because x-ray absorption in media is an exponential function of depth and because radiation and conduction both play a role in the cooling mechanism of the filter assembly, the heat transfer mechanism changes from radiation dominant to conduction dominant as the thickness increases. For a thin filter, radiation heat transfer predominates. The maximum temperature in the filter increases as the thickness increases due to the fact that the total heat load increases while the total area for radiation heat transfer remains the same. For a thick filter, conduction heat transfer predominates. When the filter thickness increases, the heat absorption per unit thickness decreases and so does the maximum temperature. At a certain thickness, the temperature in the filter is the maximum. This is the critical thickness. For third-generation synchrotron radiation facilities, the maximum temperature and thermal stresses in a filter are the main factors considered in the design of a filter assembly. It is very important to avoid designing a filter inside the critical thickness range.

This work was supported by the U.S. Department of Energy, BES-Materials Science, under contract W-31-109-Eng-38.